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KEY TO THE KALOTERMITIDAE OF EASTERN UNITED STATES WITH A NEW *NEOTERMES* FROM FLORIDA (ISOPTERA)

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Abstract.—A new species of drywood termite of the genus *Neotermes* is described and figured, and an identification key is included to separate it from nine other kalotermitids from Florida. This species was first recognized as distinct from another morphologically very similar species, *Neotermes jouteli* (Banks), on the basis of karyotypic and isozymatic differences.

Key Words: *Neotermes*, Kalotermitidae, termites

Termites resembling *Neotermes jouteli* (Banks and Snyder) 1920 but differing from that species in chromosome number and isozyme patterns were recently noted by Dr. Peter Luykx during the course of a cytogenic survey of species of the family Kalotermitidae. We were requested to seek, and herewith report, morphometric features for characterizing this new taxon to make the name available for his research. Although we are confident that most of the termite species of the United States have been described, we find that refinements in taxonomic techniques are beginning to uncover complexes among already described species (Haverty and Thorne 1989, in press). When chromosomal, isozymatic, or behavioral studies are used in termite investigations, more species may be discovered in North America.

Samples were preserved in 85% ethanol; morphological features were measured with the device described in detail by Grant (1965). Measurements consisted of the following values in millimeters: *head length*, in lateral view, the distance from the left ventral mandibular condyle to the occiput; *head width*, in dorsal view, the greatest breadth at the genae; *head depth*, in lateral view, the distance between the vertex and the ventral margin of the head capsule; *eye diameter*, the width of the eye of the imago measured from its anterior to posterior margin; *postocular distance*, in dorsal view on the imago, the shortest distance from the midpoint of the occipital margin of the head to the imaginary line connecting the posterior margins of the compound eyes; *subocular distance*, in lateral view, the shortest distance connecting the ventral margin of a compound eye with the ventral margin of the head capsule; *ocellus length* and *width*, the greatest and shortest diameters, respectively, of the ocellus; *postmentum length*, the distance from the midpoint of the labial suture to the midpoint of the inner posterior margin of the postmentum; *postmentum width*, the minimum width of the postmentum at its constriction; *length* and *width* of *pronotum*, in dorsal view, the medial length and greatest width of the pronotum; *length* and *width* of *wing*, the total length of the forewing, including the scale, and the greatest width of the forewing; *total length*, in

lateral view, the length of the body from the tip of the face to the apex of the abdomen; *length* of the *mandible*, in dorsal view, the length of the soldier mandible measured from the notch at the base of the outer mandibular condyle to the tip of the mandible (Tables 2, 4, 5).

Morphometric ratios found to have some value in identifying Florida kalotermitids included the following: *Head L/W*, the ratio of head length to head width; *Head L/D*, the ratio of head length to head depth; *Head W/D*, the ratio of head width to head depth; *Postocular distance/Eye diameter* and *Subocular distance/Eye diameter*; *Pronotum W/L*, the ratio of the greatest width to medial length of the pronotum; *Wing L/W*, the ratio of the wing length to wing width; *Wing L/Wingscale L*, and *Postmentum L/W* (Tables 3, 6, 7).

Except for a previously unidentified soldier and nymph in the National Museum Collection that had been collected by E. M. Miller in 1930, all of the material upon which this description is based was collected in south Florida by Peter Luykx. Specimens used in this study have been deposited in the following institutions: National Museum of Natural History, Smithsonian Institution, Washington, D.C. [NMNH], and the American Museum of Natural History, New York, NY [AMNH].

Table 1. A list of chromosome numbers (2n) for Florida species of Kalotermitidae (Luykx and Syren 1979, Luykx pers. comm.).

Species	Chromosome Number
Calcaritermes nearcticus	29 (♂)
Cryptotermes brevis	37 (♂), 36 (♀)
Cryptotermes cavifrons	40
Incisitermes milleri	28
Incisitermes schwarzi	32
Incisitermes snyderi	44
Kalotermes approximatus	32
Neotermes castaneus	38
Neotermes luykxi	45 (♂), 44 (♀)
Neotermes jouteli	56

Description

Neotermes luykxi Nickle and Collins New Species

Holotype.—Short-headed soldier. Florida: Broward Co. Dania. PL 389C. 30 June 1984. (Coll. P. Luykx). [NMNH]. Morphotype. Imago. Florida: Broward Co. Hollywood. PL 558. 21 August 1986. (Coll. P. Luykx). [NMNH].

Paratype series.—26 soldiers, 15 imagoes, 20 nymphs. Florida: Broward Co., Hollywood, PL 439, (P. Luykx), 6 soldiers, 5 imagoes, 4 nymphs [NMNH]; Same locality, PL 558 [morphotype sample], VIII-21-1986, 7 soldiers, 10 imagoes, 3 nymphs [NMNH, AMNH]; Florida: Broward Co., Dania, PL 389, VI-20-1984, (P. Luykx), 3 soldiers, 3 nymphs [NMNH]; PL 389C, same locality as PL 389, VI1984, 3 soldiers, 3 nymphs [NMNH]; Same locality, PL 400, VII-21-1984, (P. Luykx), 6 soldiers, 6 nymphs [NMNH, AMNH]; Florida: Dade Co., Key Largo, XII-6-1930, (Coll. E. M. Miller), 1 soldier, 1 nymph [NMNH].

Short-Headed soldier.—*Head:* 1.21× longer than wide, 1.46× longer than deep (Figs. 1E, 2E). From above, sides of head weakly convex, with greatest width at middle of head capsule. Labrum about as long as wide, broadly rounded. Antennal fossa oval; dorsal ridge well developed, extending over first article of antenna; ventral ridge weakly developed, lying flush with head capsule; from above, antennal fossa extending as a ridge to dorsal margin of clypeus. Antennae with 13 articles (rarely with 14), beadlike; article 1 broad, barrel shaped, equal in length to articles 2+3; article 2 smaller than 4; article 3 enlarged, subequal in length to 4+5; each successive article 4 through 13 similar in size, but becoming increasingly more elongated toward apex of antenna. Eyes comprised of a cluster of cells with central core darkly pigmented; eye

Table 2. TERMITE IMAGOES: means ($\bar{x}$) and ranges of measurements (in mm) of morphological features of *Neotermes, Incisitermes* and *Kalotermes* species. Numbers in parentheses after value indicate size of sample. NA = not available for measurement.

		Neotermes castaneus	*Neotermes jouteli*	*Neotermes luykxi*	*Kalotermes approximatus*	*Incisitermes snyderi*	*Incisitermes schwarzi*	*Incisitermes milleri*
# antennal articles	Range	18 (5)	18–20 (6)	17–18 (8)	16 (1)	13–16 (8)	18–19 (4)	NA
Head length	$\bar{x}$	1.59 (11)	1.44 (6)	1.31 (8)	1.42 (4)	1.07 (9)	1.47 (4)	0.86 (1)
	Range	1.39–1.71	1.35–1.49	1.24–1.37	1.22–1.55	0.98–1.14	1.35–1.59	
Head width	$\bar{x}$	1.81 (11)	1.66 (6)	1.46 (8)	1.35 (4)	1.19 (10)	1.46 (3)	0.84 (1)
	Range	1.73–1.92	1.63–1.75	1.41–1.49	1.20–1.51	1.16–1.22	1.45–1.47	
Head depth	$\bar{x}$	1.01 (8)	0.94 (6)	0.90 (8)	0.84 (4)	0.67 (10)	0.95 (4)	0.61 (1)
	Range	0.98–1.06	0.92–0.96	0.86–0.92	0.75–0.90	0.63–0.69	0.94–0.96	
Eye diameter	$\bar{x}$	0.46 (11)	0.43 (6)	0.37 (8)	0.29 (4)	0.32 (10)	0.45 (4)	0.24 (1)
	Range	0.43–0.51	0.41–0.47	0.35–0.39	0.26–0.33	0.28–0.33	0.43–0.49	
Postocular distance	$\bar{x}$	0.78 (11)	0.63 (6)	0.65 (8)	0.76 (4)	0.52 (10)	0.73 (4)	0.41 (1)
	Range	0.69–0.90	0.51–0.71	0.57–0.77	0.63–0.86	0.43–0.55	0.69–0.79	
Subocular distance	$\bar{x}$	0.33 (11)	0.28 (6)	0.22 (8)	0.31 (4)	0.16 (10)	0.31 (4)	0.16 (1)
	Range	0.28–0.39	0.26–0.31	0.20–0.24	0.26–0.33	0.14–0.18	0.31–0.33	
Ocellar L	$\bar{x}$	0.19 (11)	0.15 (6)	0.12 (8)	0.10 (4)	0.15 (10)	0.18 (4)	0.10 (1)
	Range	0.16–0.24	0.14–0.16	0.12–0.14	0.60–0.12	0.12–0.16	0.16–0.20	
Ocellar W	$\bar{x}$	0.14 (11)	0.16 (6)	0.15 (8)	0.10 (4)	0.10 (10)	0.12 (4)	0.08 (1)
	Range	0.12–0.16	0.16	0.12–0.16	0.06–0.12	0.10–0.12	0.10–0.14	
Width pronotum	$\bar{x}$	2.01 (11)	1.86 (6)	1.68 (7)	1.61 (4)	1.20 (10)	1.73 (4)	0.92 (1)
	Range	1.71–2.45	1.77–1.92	1.59–1.69	1.51–1.67	1.14–1.22	1.69–1.79	
Length pronotum	$\bar{x}$	1.09 (11)	0.97 (6)	0.91 (7)	0.88 (4)	0.67 (10)	1.00 (4)	0.57 (1)
	Range	1.00–1.24	0.94–1.00	0.88–0.94	0.79–0.98	0.65–0.69	0.94–1.04	
Total length	$\bar{x}$	8.66 (11)	8.17 (6)	7.28 (7)	8.21 (4)	5.32 (10)	8.83 (4)	5.58 (1)
	Range	6.42–10.58	7.83–8.92	6.50–7.92	6.50–9.50	4.83–5.92	8.42–9.50	
Wing length	$\bar{x}$	12.53 (8)	11.15 (5)	10.29 (7)	7.83 (2)	8.93 (6)	11.89 (3)	NA
	Range	11.58–13.75	11.00–11.25	9.92–10.83	7.83	8.83–9.00	11.25–12.92	
Wing width	$\bar{x}$	3.42 (8)	3.15 (5)	2.73 (7)	2.08 (2)	2.36 (6)	2.92 (3)	NA
	Range	3.08–4.00	3.00–3.25	2.67–2.92	2.08	2.17–2.75	2.83–3.00	
Wing scale length	$\bar{x}$	1.48 (11)	1.13 (6)	1.13 (7)	1.21 (4)	0.95 (10)	1.20 (3)	0.92 (1)
	Range	1.17–1.92	0.83–1.33	1.08–1.25	1.08–1.25	0.83–1.08	1.17–1.25	

Table 3. TERMITE SHORT-HEADED SOLDIERS: means ($\bar{x}$) and ranges of measurements (in mm) of morphological features of *Neotermes*, *Kalotermes*, and *Insicitermes* species. Numbers in parentheses after value indicate size of sample. NA = not available for measurement.

		Neotermes castaneus	*Neotermes jouteli*	*Neotermes luykxi*	*Incisitermes snyderi*	*Incisitermes schwarzi*	*Incisitermes milleri*	*Kalotermes approximatus*
# antennal articles	Range	16 (2)	13–15 (10)	13–14 (12)	9–11 (2)	13–14 (5)	11 (3)	14 (1)
Head length	$\bar{x}$	3.75 (10)	2.26 (13)	2.07 (17)	2.03 (8)	2.12 (5)	1.84 (4)	2.57 (3)
	Range	3.50–4.25	2.08–2.83	1.75–2.10	1.96–2.17	2.00–2.25	1.83–1.87	2.50–2.62
Head width	$\bar{x}$	2.85	1.86 (13)	1.71 (17)	1.38 (8)	1.72 (5)	1.02 (4)	1.58 (3)
	Range	2.67–3.04	1.71–2.25	1.58–1.92	1.37–1.42	1.67–1.79	1.00–1.04	1.58
Head depth	$\bar{x}$	1.96	1.31 (13)	1.20 (17)	1.14 (8)	1.26 (5)	0.87 (4)	1.36 (3)
	Range	1.87–2.21	1.21–1.62	1.04–1.46	1.12–1.17	1.17–1.33	0.79–0.92	1.33–1.37
Mandible length	$\bar{x}$	2.25	1.45 (13)	1.40 (17)	1.31 (8)	1.47 (5)	0.95 (4)	1.48 (2)
	Range	2.17–2.37	1.37–1.79	1.17–1.54	1.21–1.37	1.29–1.58	0.92–1.00	1.46–1.50
Postmentum length	$\bar{x}$	2.62	1.51 (13)	1.36 (17)	1.44 (8)	1.48 (5)	1.36 (4)	1.85 (3)
	Range	2.12–3.08	1.42–1.87	1.08–1.79	1.37–1.54	1.42–1.54	1.33–1.42	1.71–1.92
Postmentum width	$\bar{x}$	0.41	0.31 (13)	0.31 (17)	0.26 (8)	0.27 (5)	0.20 (4)	0.28 (3)
	Range	0.37–0.46	0.25–0.42	0.29–0.37	0.21–0.29	0.25–0.37	0.17–0.25	0.25–0.29
Width pronotum	$\bar{x}$	2.59	2.04 (13)	1.80 (17)	1.31 (8)	1.86 (5)	0.94 (4)	1.87 (2)
	Range	2.46–2.87	1.87–2.46	1.58–2.12	1.29–1.37	1.71–1.96	0.83–1.04	1.83–1.92
Length pronotum	$\bar{x}$	1.14	0.96 (13)	0.82 (17)	0.75 (8)	0.82 (5)	0.69 (4)	0.47 (2)
	Range	1.04–1.25	0.83–1.12	0.67–1.00	0.71–0.83	0.75–0.87	0.67–0.71	0.47
Total length	$\bar{x}$	11.09 (8)	8.05 (10)	7.25 (6)	5.53 (6)	7.65 (5)	5.98 (4)	8.28 (3)
	Range	10.67–11.58	7.00–9.08	6.92–7.67	5.17–7.17	6.75–7.92	5.42–6.42	7.83–8.58

Table 4. TERMINTE LONG-HEADED SOLDIERS: means ($\bar{x}$) and ranges of measurements (in mm) of morphological features of *Neotermes* and *Incisitermes* species from Florida. Numbers in parentheses after value indicate size of sample. NA = not available for measurement.

		Neotermes castaneus	*Neotermes jouteli*	*Neotermes luykxi*	*Incisitermes snyderi*	*Incisitermes schwarzi*	*Incisitermes milleri*
# antennal articles	Range	16 (2)	15–16 (6)	NA	12 (2)	13–15 (8)	11 (1)
Head length	$\bar{x}$	3.75 (10)	3.24 (6)	3.14 (4)	2.41 (2)	3.57 (8)	2.00 (2)
	Range	3.50–4.25	3.04–3.42	3.00–3.42	2.37–2.46	3.21–3.92	2.00
Head width	$\bar{x}$	2.85 (10)	2.30 (6)	2.00 (4)	1.48 (2)	2.13 (8)	1.12 (2)
	Range	2.67–3.04	2.04–2.46	1.96–2.04	1.46–1.50	1.96–2.21	1.12
Head depth	$\bar{x}$	1.96 (10)	1.67 (6)	1.49 (4)	1.23 (2)	1.56 (8)	1.02 (2)
	Range	1.87–2.21	1.62–1.79	1.46–1.54	1.21–1.25	1.42–1.67	1.00–1.04
Mandible length	$\bar{x}$	2.25 (10)	1.84 (6)	1.62 (4)	1.37 (2)	1.71 (8)	1.06 (2)
	Range	2.17–2.37	1.58–2.21	1.58–1.67	1.37	1.67–1.75	1.04–1.08
Postmentum length	$\bar{x}$	2.62 (10)	2.38 (6)	2.34 (4)	1.75 (2)	2.75 (8)	1.54 (1)
	Range	2.12–3.08	2.04–2.58	2.12–2.50	1.75	2.42–3.12	1.54
Postmentum width	$\bar{x}$	0.41 (10)	0.48 (6)	0.33 (4)	0.29 (2)	0.28 (8)	0.19 (2)
	Range	0.37–0.46	0.25–0.58	0.29–0.37	0.29	0.25–0.37	0.17–0.21
Width pronotum	$\bar{x}$	2.59 (10)	2.50 (6)	2.16 (4)	1.44 (2)	2.33 (8)	1.08 (1)
	Range	2.46–2.87	2.29–2.71	2.12–2.25	1.42–1.46	2.17–2.50	1.08
Length pronotum	$\bar{x}$	1.14 (10)	1.21 (6)	1.08 (4)	0.89 (2)	1.23 (8)	0.79 (1)
	Range	1.04–1.25	1.17–1.29	1.04–1.17	0.83–0.90	1.12–1.33	0.79
Total length	$\bar{x}$	11.09 (8)	9.68 (6)	NA	NA	10.72 (8)	6.83 (1)
	Range	10.67–11.58	8.75–10.75			10.08–11.25	

cluster situated a distance of less than diameter of cluster from antennal fossa. Mandibles ⅔ as long as head capsule; in lateral view, curving upward anteriorly; mandible dentition and shape of postmentum as in Fig. 1E.

Thorax: Pronotum broader than head capsule. Anterior margin broadly concave but not incised; posterior margin weakly notched medially. Range of greatest width/medial length 2.04–2.37.

Legs: Femora inflated, 2.3–2.5× longer than wide. Tibial spurs 3:3:3. Arolia absent.

Color: Mandibles glossy black. Head capsule reddish-brown anteriorly, becoming more yellowish-brown along posterior margin. Antennae light reddish-brown, darker basally. Labrum reddish-brown; clypeus translucent or whitish. Eyes purplish-gray. Body and legs whitish-yellow.

Imago morphotype.—*Head:* In dorsal view, head length from base of mandibles 0.78–0.83× as long as head width just behind compound eyes. Compound eyes 0.35–0.39 mm in diameter; subocular distance ca. 0.62× diameter of compound eye; postocular distance ca. 1.78× diameter of compound eye. Compound eye separated from antennal socket by less than 0.1 mm. Ocelli oval, with greatest diameter 0.15 mm; separated from compound eye by less than ocellar diameter. Antenna with 18 articles, 2.1–2.3 mm in length, ca. 1.7× longer than head length to base of mandibles.

Thorax: Pronotum 1.87× broader than long; anterior margin broadly concave; posterior margin medially notched.

Legs: Femora slightly enlarged or inflated, 2.6–2.8× longer than wide. Tibial spurs 3:3:3. Arolia present.

Wings: Hyaline, yellowish with brown anterior veins. Venation as in all *Neotermes*, with M nearly as sclerotized as Rs, running closer to Rs than to Cu. Length of forewing 9.9–10.8 mm ($\bar{x}$ = 10.3 mm), 3.77× longer than its greatest width (Fig. 3B).

Table 5. Ratios of morphological features of imagoes of *Kalotermes*, *Neotermes*, and *Incisitermes* termites from Florida. Numbers in parentheses after value indicate size of sample. NA = not available for measurement.

		Neotermes castaneus	*Neotermes jouteli*	*Neotermes luykxi*	*Kalotermes approximatus*	*Incisitermes schwarzi*	*Incisitermes snyderi*	*Incisitermes milleri*
Head L/W	$\bar{x}$	0.88 (11)	0.86 (6)	0.81 (8)	1.05 (4)	1.00 (3)	0.89 (9)	1.02 (1)
	Range	0.73–0.93	0.82–0.91	0.83–0.96	1.01–1.13	0.92–1.09	0.83–0.96	
Head L/D	$\bar{x}$	1.51 (11)	1.52 (6)	1.46 (8)	1.69	1.54 (4)	1.61 (9)	1.40 (1)
	Range	1.38–1.61	1.40–1.59	1.39–1.52	1.62–1.77	1.41–1.66	1.47–1.81	
Head W/D	$\bar{x}$	1.75 (11)	1.76 (6)	1.64 (8)	1.62	1.53 (3)	1.79 (10)	1.37 (1)
	Range	1.65–1.94	1.70–1.83	1.55–1.74	1.55–1.72	1.51–1.56	1.68–1.87	
Pstoc. D/Eye Dia.	$\bar{x}$	1.68 (11)	1.44 (6)	1.78 (8)	2.55	1.62 (3)	1.63 (10)	1.71 (1)
	Range	1.48–2.00	1.25–1.57	1.55–2.11	2.38–2.67	1.60–1.65	1.40–1.93	
Suboc. D/Eye Dia.	$\bar{x}$	0.72 (11)	0.66 (6)	0.62 (8)	1.04	0.70 (4)	0.53 (10)	0.66 (1)
	Range	0.61–0.86	0.59–0.71	0.53–0.70	0.93–1.15	0.63–0.77	0.44–0.57	
Pronotum W/L	$\bar{x}$	1.83 (11)	1.91 (6)	1.87 (7)	1.84	1.73 (4)	1.79 (10)	1.61 (1)
	Range	1.56–2.07	1.85–1.96	1.84–1.95	1.71–1.95	1.68–1.80	1.70–1.87	
Wing L/W	$\bar{x}$	3.60 (8)	3.55 (5)	3.77 (7)	3.76 (2)	4.07 (3)	3.80 (6)	NA
	Range	3.32–4.13	3.43–3.67	3.60–4.06	3.76	3.94–4.30	3.21–4.11	
WingL/WingScale	$\bar{x}$	7.83 (8)	10.12 (5)	9.11 (7)	6.75 (2)	9.94 (3)	9.29 (6)	NA
	Range	7.00–10.46	8.37–13.60	8.40–9.69	6.27–7.23	9.64–10.33	8.23–10.28	

Table 6. Ratios of morphological features of long-headed soldier termites from Florida. Numbers in parentheses after value indicate size of sample. NA = not available for measurement.

		Neotermes castaneus	*Neotermes jouteli*	*Neotermes luykxi*	*Incisitermes snyderi*	*Incisitermes schwarzi*	*Incisitermes milleri*
Head L/W	$\bar{x}$	1.32 (10)	1.42 (6)	1.57 (4)	1.63 (2)	1.78 (8)	1.78 (2)
	Range	1.22–1.41	1.27–1.65	1.50–1.67	1.63–1.64	1.60–1.84	1.78
Head L/D	$\bar{x}$	1.91 (10)	1.94 (6)	2.12 (4)	1.96 (2)	2.29 (8)	1.89 (2)
	Range	1.83–2.09	1.82–2.08	2.06–2.21	1.96–1.97	2.22–2.46	1.78–2.00
Head W/D	$\bar{x}$	1.45 (10)	1.37 (6)	1.35 (4)	1.20 (2)	1.37 (8)	1.10 (2)
	Range	1.38–1.51	1.26–1.45	1.32–1.37	1.20–1.21	1.27–1.43	1.08–1.12
Head L/Mandible L	$\bar{x}$	1.67 (10)	1.77 (6)	1.93 (4)	1.76 (2)	2.08 (8)	1.88 (2)
	Range	1.53–1.89	1.55–2.13	1.89–2.05	1.73–1.79	1.88–2.35	1.85–1.92
Pronotum W/L	$\bar{x}$	2.28 (10)	2.07 (6)	2.00 (4)	1.61 (2)	1.89 (8)	1.37 (2)
	Range	2.03–2.44	1.83–2.21	1.93–2.04	1.48–1.75	1.74–2.00	1.37
Postment. L/min. W	$\bar{x}$	6.41 (10)	4.62 (5)	7.09 (4)	6.00 (2)	8.04 (8)	8.32 (2)
	Range	5.18–7.11	3.77–6.02	6.37–8.57	6.00	6.44–9.37	7.40–9.25

Color: Head, pronotum, legs, and tergites of abdomen uniformly yellowish; clypeus whitish-yellow; labrum same color as head capsule. Sternites lighter yellow than tergites.

Variation: Twenty-two soldier paratypes are short-headed forms and four are long-headed forms (Figs. 1B, E and 2D, E). Although all have pigmented eyespots, the degree of pigmentation varies from light to dark grey, and in some specimens they appear purplish. Both soldier forms vary in size (Tables 3, 4). Although there are no overlaps in most measurements between soldier forms, the largest short-headed and smallest long-headed soldiers share the same values for head depth, postmentum width, and pronotum width. Among morphometric ratios for identification of soldier forms, only Head W/D overlaps in the two forms (Tables 6, 7). Imago paratypes also vary in size (Tables 2, 5).

Diagnosis.—*Soldier:* We recognize *luykxi* as a species of *Neotermes* on the basis of the shape of the pronotum, which is not deeply incised as in species of *Incisitermes*. Of the Florida species of *Neotermes*, *luykxi* and *jouteli* are more closely related and are easily distinguished from *castaneus* (Burmeister 1839), a species with only one form of soldier. *Neotermes castaneus* is larger, has a slightly broader head as seen in dorsal view (Fig. 2A–C), and has unpigmented eyespots. Mandible dentition may also help to separate these species (Fig. 4B). *Neotermes luykxi* and *N. jouteli* both have pigmented eyespots and resemble one another in the head shapes of long- and short-headed soldiers. The L/W ratio for short-headed soldiers of both *N. jouteli* and *N. luykxi* is 1.21; for long-headed soldiers, the ratio is 1.42 for *N. jouteli* and 1.57 for *N. luykxi*. The L/W ratio for *N. castaneus* is 1.32. The long-headed soldier of *N. luykxi* usually has both a narrower head and a longer, narrower postmentum than *N. jouteli*. Although *N. luykxi* is generally smaller than *N. jouteli*, there is overlap for all measurements in soldiers of the same head form, and the mean values reflect only trends for each species (See Tables). The most significant difference between the two species is chromosome number (45[♂] 44[♀] for *N. luykxi*, 56 [both sexes] for *N. jouteli*) (Table 1). The morphometric difference that seems to be most useful in differentiating these two species is the ratio of the postmentum length to its minimum width. For short-headed soldiers this ratio is 4.41 for *N. luykxi* and 4.98 for *N. jouteli*. For long-headed soldiers it is 7.09

Table 7. Ratios of morphological features of short-headed soldier termites from Florida. Numbers in parentheses after value indicate size of sample available for measurement. NA = not available for measurement.

		Neotermes jouteli	*Neotermes luykxi*	*Incisitermes snyderi*	*Incisitermes schwarzi*	*Incisitermes milleri*	*Kalotermes approximatus*
Head L/W	$\bar{x}$	1.21 (13)	1.21 (17)	1.46 (8)	1.23 (5)	1.80 (4)	1.62 (3)
	Range	1.16–1.39	1.10–1.31	1.42–1.57	1.19–1.32	1.72–1.87	1.58–1.66
Head L/D	$\bar{x}$	1.77 (13)	1.72 (17)	1.78 (8)	1.68 (5)	2.11 (4)	1.91 (3)
	Range	1.59–2.43	1.60–1.84	1.71–1.86	1.59–1.80	2.00–2.14	1.87–1.97
Head W/D	$\bar{x}$	1.42 (13)	1.42 (17)	1.21 (8)	1.37 (5)	NA	1.16 (3)
	Range	1.36–1.54	1.31–1.52	1.18–1.26	1.28–1.43		1.15–1.19
Head L/Mandible L	$\bar{x}$	1.53 (13)	1.51 (17)	1.53 (8)	1.44 (5)	1.94 (4)	1.73 (2)
	Range	1.39–1.84	1.38–1.73	1.42–1.62	1.30–1.64	1.87–2.00	1.71–1.75
Pronotum W/L	$\bar{x}$	2.15 (13)	2.20 (17)	1.75 (8)	2.26 (5)	1.36 (4)	1.95 (2)
	Range	1.95–2.54	2.04–2.37	1.55–1.88	2.05–2.44	1.25–1.47	1.91–2.00
Postmentum L/min. W	$\bar{x}$	4.98 (13)	4.41 (17)	5.57 (8)	4.33 (5)	7.17 (4)	6.70 (3)
	Range	4.22–5.83	3.71–6.14	4.71–6.80	4.25–4.62	5.67–8.00	5.85–7.67

for *N. luykxi*, 4.62 for *N. jouteli*, and 6.41 for *N. castaneus*. *Neotermes luykxi* and *N. jouteli* also differ in isozyme composition (Luykx et al., in prep.).

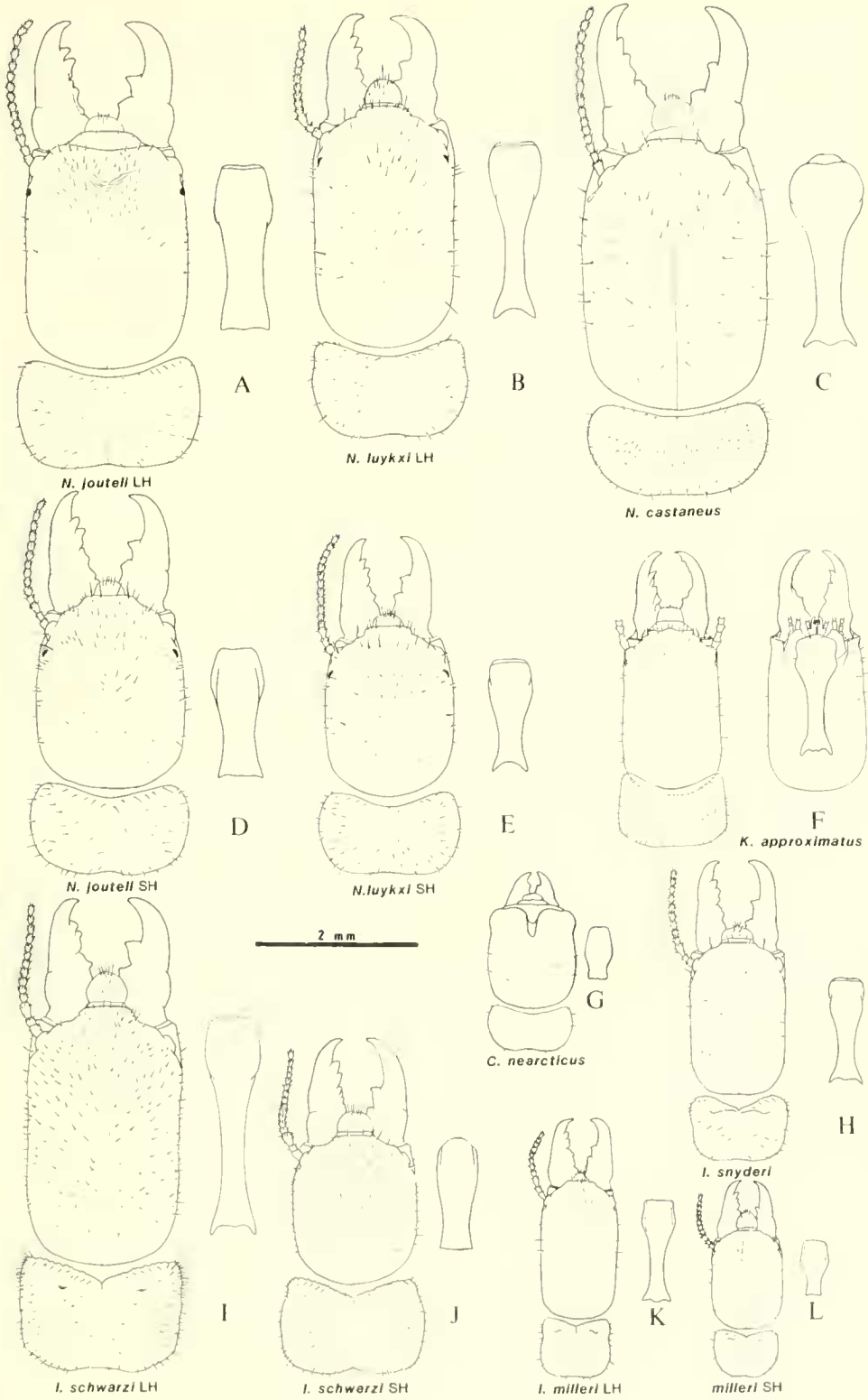
Imago: Assignment of the imago of *N. luykxi* to *Neotermes* was made on the basis of wing venation and length of the anterior margin of the second marginal tooth of the left mandible. Differentiating the three Florida species of *Neotermes* depends primarily upon a comparison of all morphometric features listed in Tables 2 and 5, none of which by itself is useful in identifying an individual specimen. *Neotermes luykxi* is the smallest of the three species, however, and the diameter of its compound eye is consistently smaller. The presence of long setae on the head and pronotum is a diagnostic character; *N. castaneus* generally has long setae on the head and pronotum, while *N. jouteli* and *N. luykxi* have only scattered short setae (Fig. 6A–I). Wing length, wing scale length, and head width are generally largest for *N. castaneus* and smallest for *N. luykxi* (Tables 2, 5).

Discussion.—Morphologically, *Neotermes jouteli* is most similar to this new species, but Luykx et al. (in prep.) found that the chromosome number (2n) of *N. jouteli* was 56 [both sexes] and only 45 [♂] and 44 [♀] for *N. luykxi*. Luykx also found interspecific differences in a series of isozymes among five selected kalotermitids (including *N. jouteli* and *N. luykxi*).

It has become increasingly common to identify sibling species of animals by using chromosomal differences. Once phena have been segregated on the basis of such differences, it is usually possible to identify morphological characters which are helpful in distinguishing the forms. Such was the case with a European mole cricket, *Gryllotalpa septemdecimchromosomica* Ortiz (1958), and more recently with a complex of other sibling species of *Gryllotalpa*: *quindecim*, *sedecim*, *octodecim*, and *viginti* (Baccetti and

→

Fig. 1. Termite soldiers, head and pronotum, dorsal view. Also figured beside each soldier head: postmentum, ventral view. A, *Neotermes jouteli*, long-head (LH); B, *N. luykxi*, LH; C, *N. castaneus*; D, *N. jouteli*, short-head (SH); E, *N. luykxi*, SH; F, *Kalotermes approximatus*; G, *Calcaritermes nearcticus*; H, *Incisitermes snyderi*; I, *I. schwarzi*, LH; J, *I. schwarzi*, SH; K, *I. milleri*, LH; L, *I. milleri*, SH.


A
B
C
N. loutelli LH
N. luykxi LH
N. castaneus
D
E
F
K. approximatus
N. loutelli SH
N.luykxi SH
2 mm
G
C. nearcticus
H
I. snyderi
I
J
K
L
I. schwarzi LH
I. schwerzi SH
I. milleri LH
milleri SH

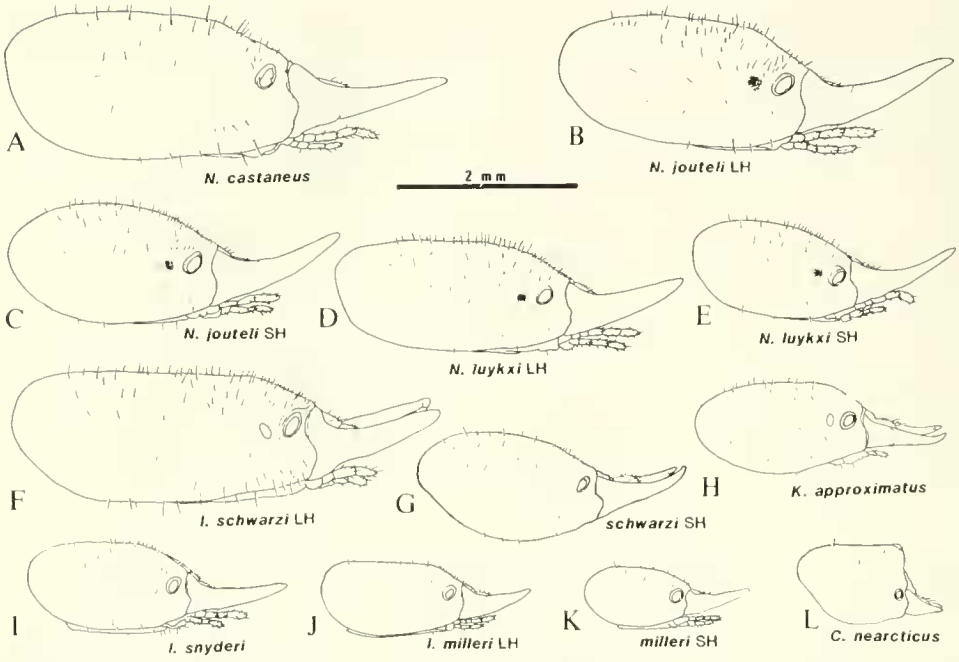


Fig. 2. Termite soldiers, head profile. A, *Neotermes castaneus*; B, *N. jouteli*, long-head (LH); C, *N. jouteli*, short-head (SH); D, *N. luykxi*, LH; E, *N. luykxi*, SH; F, *Incisitermes schwarzi*, LH; G, *I. schwarzi*, SH; H, *Kalotermes approximatus*; I, *I. snyderi*; J, *I. milleri*, LH; K, *I. milleri*, SH; L, *Calcaritermes nearcticus*.

Capra 1978). These species, otherwise morphologically very similar to *Gryllotalpa gryllotalpa* (L.), have chromosome complements of 17, 15, 16, 18, and 14, respectively, compared with 12 for *G. gryllotalpa*. Once it was determined that different chromosomal numbers occurred within the complex, it was possible to establish morphometric parameters of the variable characters for each species.

As in *Incisitermes milleri* (Emerson), *I. snyderi* (Light), *I. schwarzi* (Banks), and *Neotermes jouteli, N. luykxi* soldiers occur as long-headed or as short-headed forms. Short-headed forms are usually more common than long-headed ones within most samples we have seen. The different head forms probably result from differences in the stage of nymphal development when soldier differentiation occurs. Grassé and Noirot (1958) demonstrated that young *Kalotermes flavicollis* (F.) colonies developed soldiers from 2nd and 3rd instar larvae, while older colonies developed soldiers from 4th and 5th instar larvae.

There are five genera of drywood termites in the eastern United States: *Calcaritermes* (*nearcticus* (Snyder 1933)), *Cryptotermes* (*cavifrons* Banks 1906 and *brevis* (Walker 1853)), *Incisitermes* (*snyderi, schwarzi*, and *milleri*), *Kalotermes* (*approximatus* Banks and Snyder 1920), and *Neotermes* (*castaneus, jouteli*, and the new species *luykxi*). All of these species are known to occur in Florida.

Kalotermes approximatus is not usually economically important, except in rare cases when it becomes locally abundant. It is generally associated with dead wood in sand dunes in northern Florida, Alabama, Mississippi, and Louisiana, and northward along the coastal plain into southern Virginia. Weesner (1965) reported this species in homes in Waco, Texas, in 1957 and 1958

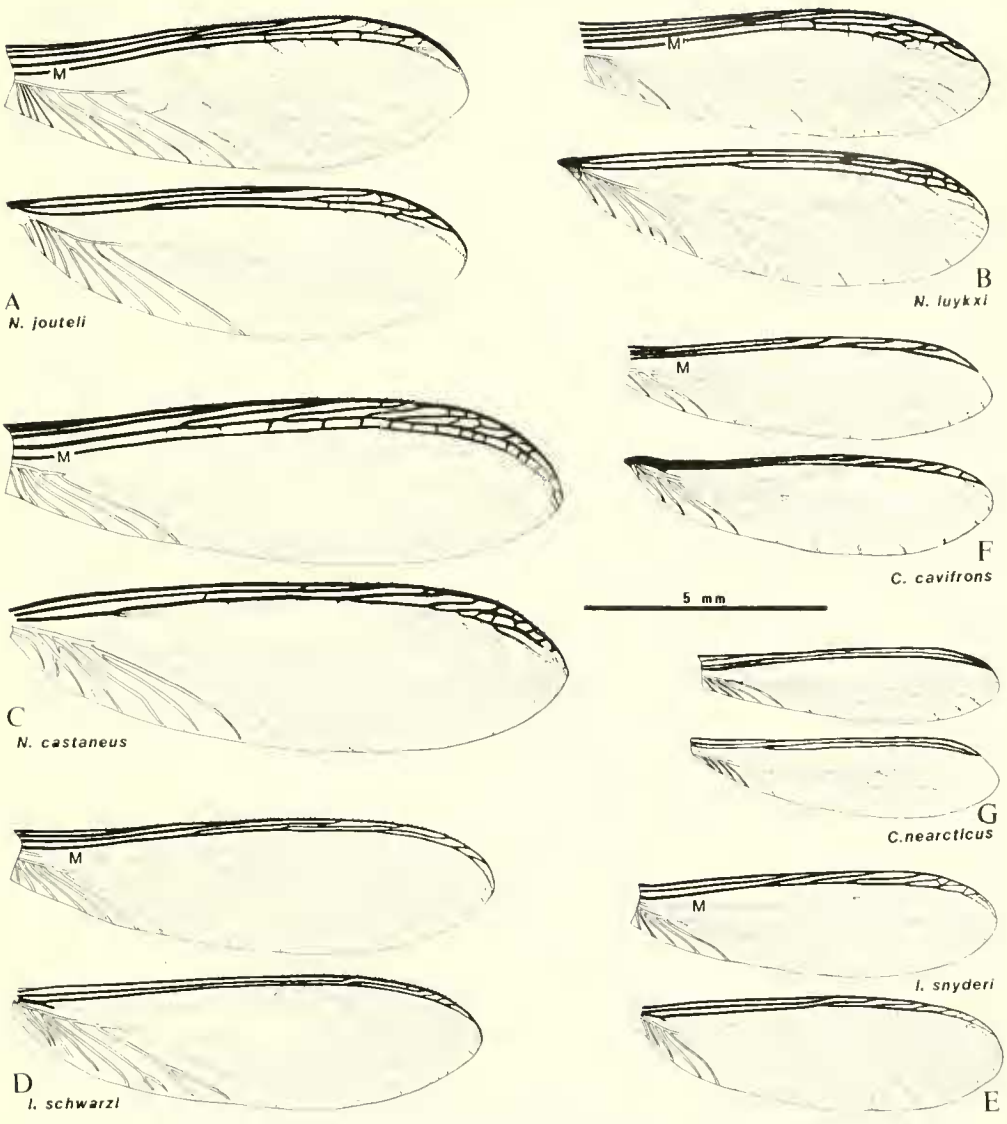


Fig. 3. Wings of alates of kalotermitids. A, *Neotermes jouteli*; B, *N. luykxi*; C, *N. castaneus*; D, *Incisitermes schwarzi*; E, *I. snyderi*; F, *Cryptotermes cavifrons*; G, *Calcaritermes nearcticus*. (M = medius vein.)

according to National Pest Control Association Records, but we have no specimens to confirm its presence in that state.

The two genera of kalotermitids most likely to be encountered in southern Florida are *Neotermes* and *Incisitermes*. *Neotermes jouteli* occurs in southern Florida, Jamaica, the West Indies, and Mexico. *Neotermes castaneus* occurs in southern Florida, West Indies, Central and South America. *Neotermes luykxi* is presently known only from Monroe, Dade, and Broward Counties, Florida. *Neotermes* species tend to be more moisture-dependent than those of *Incisitermes* (Collins 1969). *Neotermes jouteli* may enter man-made structures, infesting wet wood or wood that becomes wet from time to time. *Neotermes castaneus* also has been

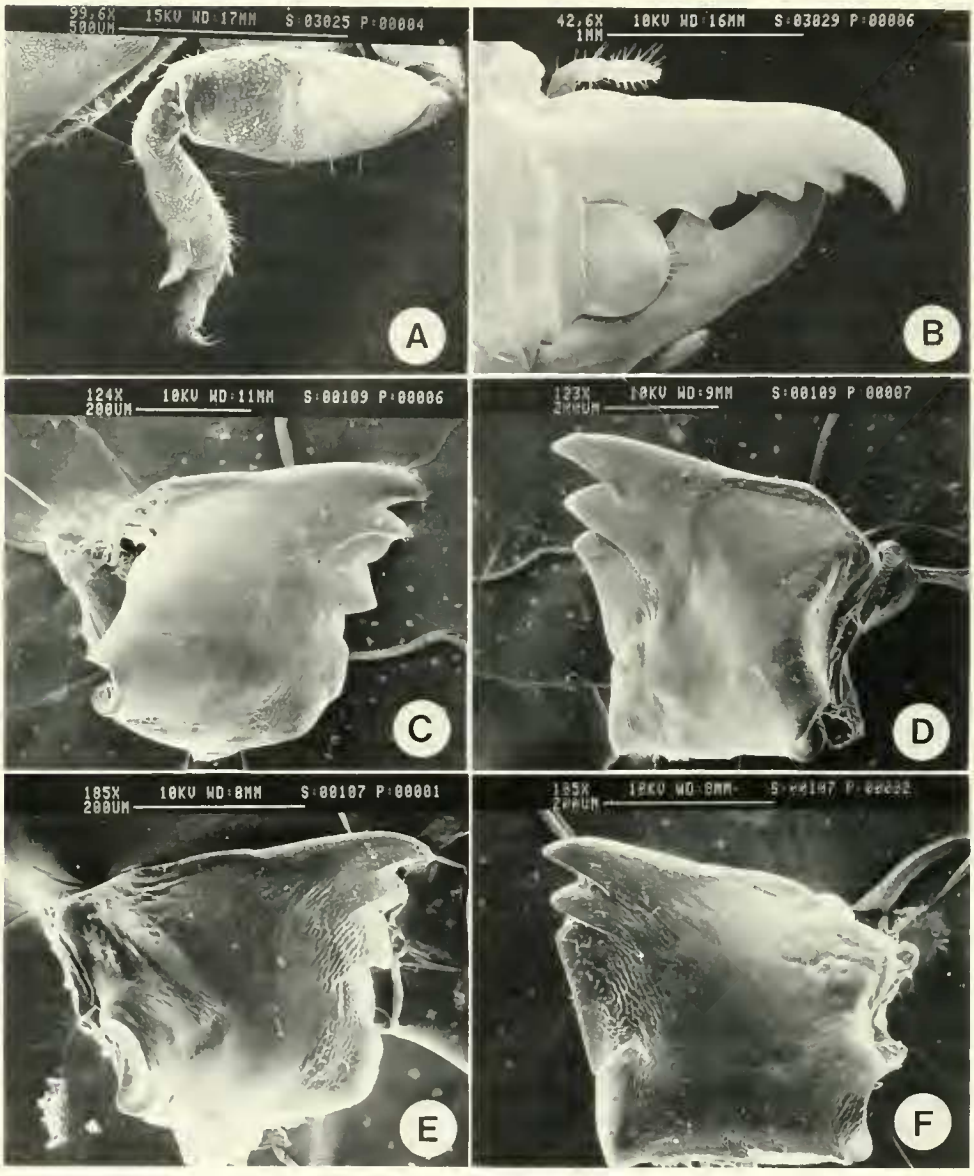


Fig. 4. Scanning electron micrographs of morphological features of kalotermitid termites. A, *Calcaritermes nearcticus*, apex of left foretibia, lateral aspect. B, *Neotermes castaneus* soldier, left mandible, dorsal aspect. C, D. *Neotermes castaneus*, imago mandibles: C, left, D, right. E, F. *Cryptotermes brevis*, imago mandibles: E, left, F, right.

recorded as a pest of avocado, guava, and citrus trees in south Florida and other parts of its range, attacking dead wood of injuries and then invading adjacent living parts of the trees (Miller 1949, Araujo 1970).

Incisitermes snyderi is widespread along the Coastal Plain from Texas to Florida and northward to South Carolina and in Central America and several islands in the Caribbean. It occurs commonly in dead cypress (*Taxodium* spp.) in the United States, causing extensive damage to untreated wood and

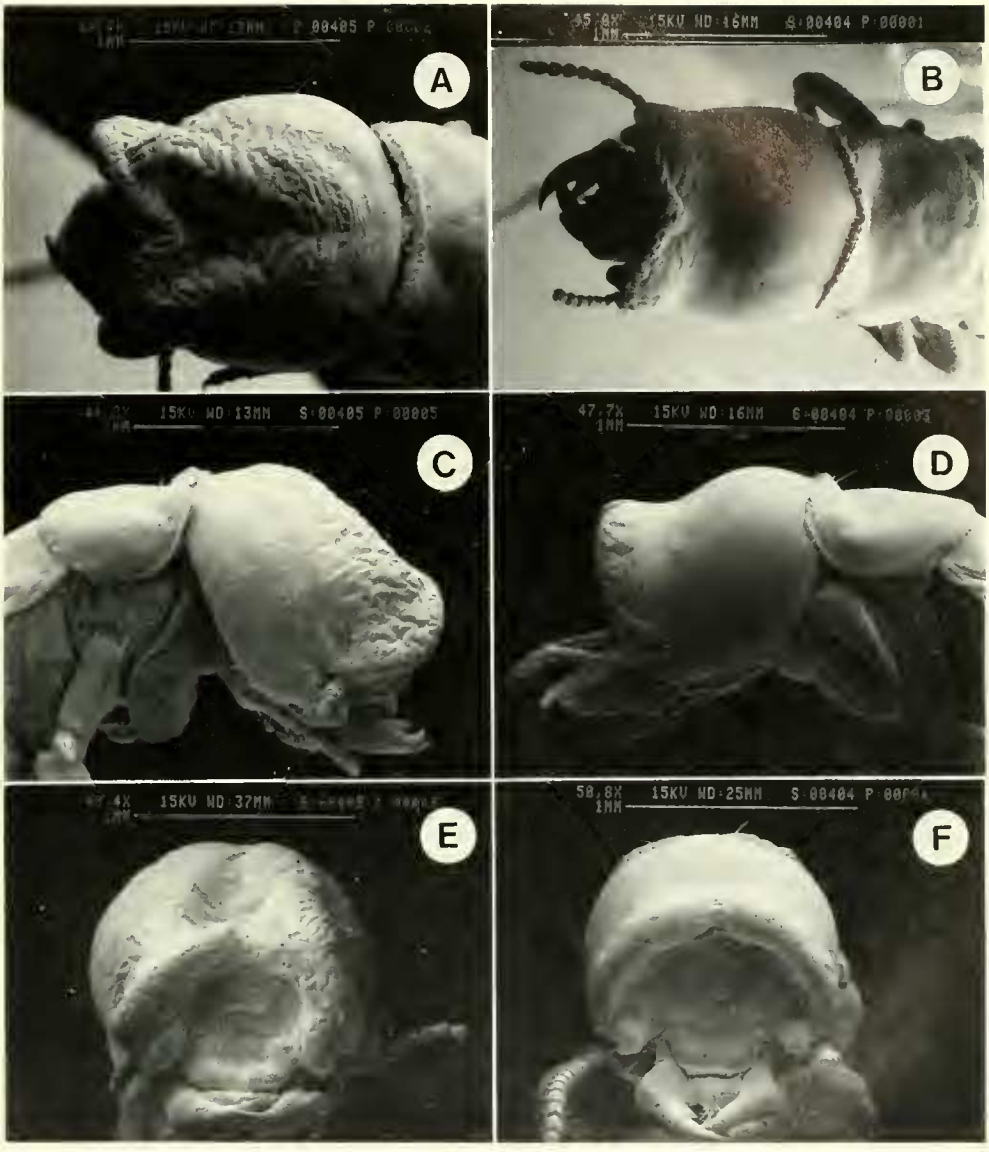
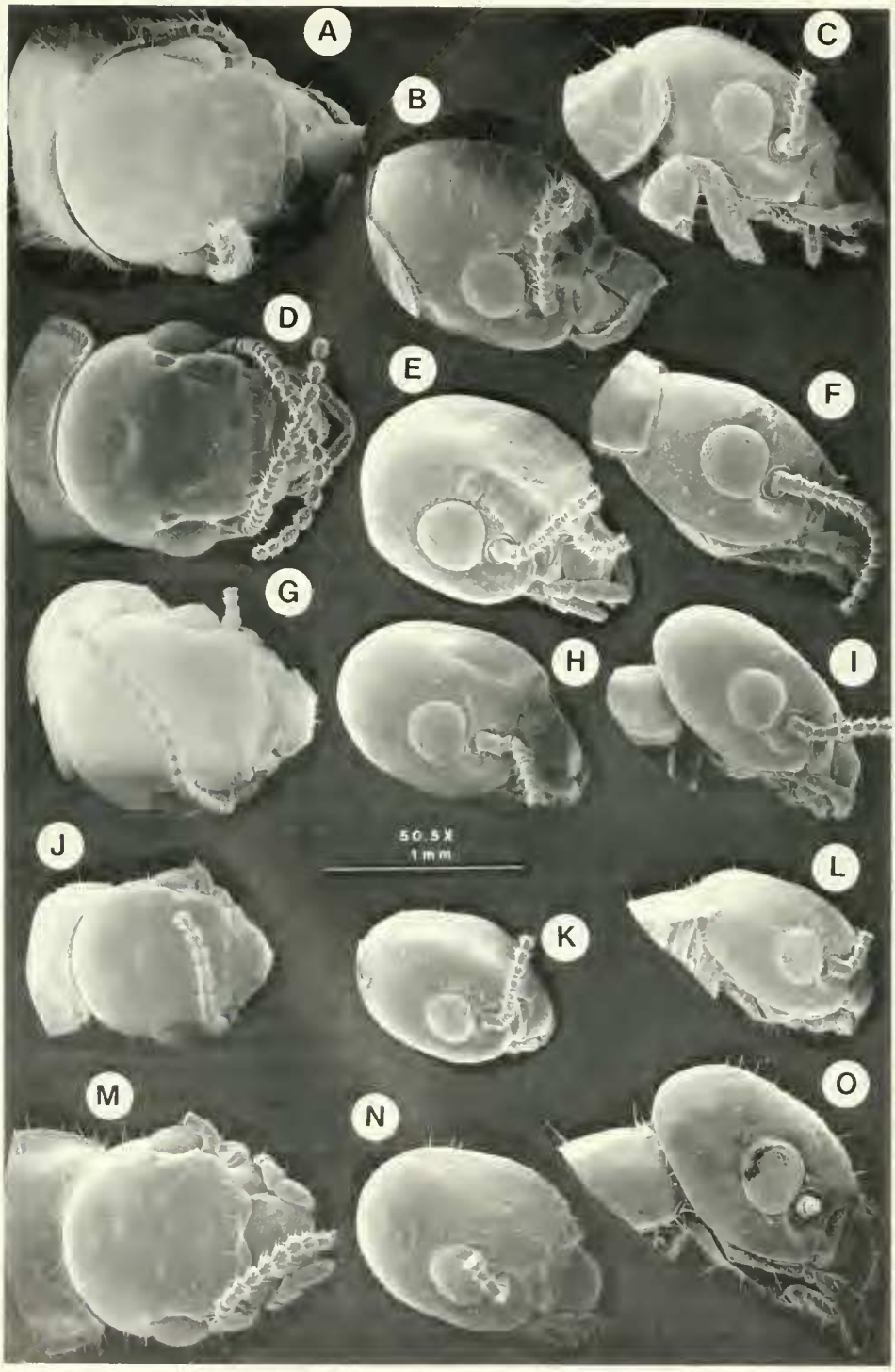


Fig. 5. Scanning electron micrographs of morphological features of kalotermitid termites. A, C, E. *Cryptotermes brevis*, soldier: A, dorsal, C, lateral, E, frontal aspect. B, D, F. *Cryptotermes cavifrons*, soldier: B, dorsal, D, lateral, F, frontal aspect.

fence posts (Miller 1949). *Incisitermes schwarzi*, found commonly in south Florida, also occurs in eastern Mexico (Yucatan) and throughout the West Indies. Like *Neotermes jouteli*, *I. schwarzi* is found in habitats with more available moisture and higher temperatures than *I. snyderi*. *Incisitermes milleri* is known only from the forested areas of the Florida Keys and Jamaica and is found in the sound wood of dead stumps.

The remaining drywood termites in this region all have soldiers with phragmotic (stopper-like) heads. *Calcaritermes* has nu-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merous species in the Neotropics but only a single species, *nearcticus* (Banks 1918), in the United States. *Calcaritermes nearcticus* is found in natural habitats in northern Florida but has not yet been recorded from man-made structures. In contrast, termites of the genus *Cryptotermes* are major pests. *Cryptotermes cavifrons* has been found in natural habitats throughout peninsular Florida, islands of the Caribbean and Central America (Araujo 1977), but *Cryptotermes brevis,* the more important pest species of the two, is known only from the dry wood of man-made structures in the United States and elsewhere in the world. It is a common household pest from North Carolina through Florida to Texas and is frequently found in furniture, picture frames, and other wooden items that have been transported to northern states from areas of infestation in the South and other warm regions of the world.

The following identification key resolves some of the difficulties in determining termites from the eastern United States.

Key to the Ten Species of Kalotermitidae Occurring in Eastern United States

IMAGOES

1. Anterior edge of second marginal tooth of left mandible elongated, longer than straight line transect of posterior edge of first marginal tooth (Fig. 4E) 2
– Anterior edge of second marginal tooth of left mandible not elongated, subequal in length to straight line transect of posterior edge of first marginal tooth (Fig. 4C) 6
2. Media (M) of forewing running midway between radial sector (Rs) and cubitus (Cu) and extending to apex of wing (Fig. 3D, E) [*Incisitermes*] 3
– Media (M) of forewing curving anteriorly and joining radial sector at about two-thirds length of wing from suture (Fig. 3F) [*Cryptotermes*] 5
3. Body length 7–8 mm; body dark brown . . . . . *Incisitermes milleri*
– Body length greater than 10 mm, but usually not exceeding 16 mm; body yellow to yellowish brown 4
4. Body length 15–16 mm; yellow-brown; wing length (including wing scale) greater than 10 mm (Fig. 3D); head shape as in Fig. 6M–O . . . . . *Incisitermes schwarzi*
– Body length 10–12 mm; yellowish; wing length less than 10 mm (Fig. 3E); head shape as in Fig. 6J–L . . . . . *Incisitermes snyderi*
5. Body length 10–12 mm; head width behind eyes greater than 1.0 mm; antenna usually with 16–18 articles . . . . . *Cryptotermes brevis*
– Body length less than 10 mm; head width less than 1.0 mm; antenna usually with fewer than 16 articles . . . . . *Cryptotermes cavifrons*
6. M vein of forewing unsclerotized, located midway between Rs and Cu; compound eye less than 0.35 mm in diameter; ocellus less than 0.12 mm in diameter; head length/width ratio greater than 1.0; body sooty black; wings shorter than body . . . . . *Kalotermes approximatus*
– M vein of forewing nearly as sclerotized as Rs, located closer to Rs than to Cu; without other above combination of characters . . . 7
7. Rs and M of forewing close together, without crossveins; Cu equidistant between M and anal margin (Fig. 3G) *Calcaritermes nearcticus*
– Rs and M of forewing wider apart, with several crossveins extending from Rs to costal border; Cu closer to M than to anal margin (Fig. 3C) [*Neotermes*] 8
8. Body length 15–16 mm; wing length greater than 12 mm; wing dark brown; forewing with numerous crossveins between Rs and M (Fig. 3C); body darkly pigmented; head and pronotum usually with both long and short setae (Fig. 6A–C) . . . . . *Neotermes castaneus*
– Body length less than 15 mm; wing length 9.0–11.5 mm; wing clear or only slightly pigmented; forewing with a few crossveins between Rs and M (Fig. 3A, B); body golden or yellow; head and pronotum with short setae only (Fig. 6D–I) 9
9. Mean total body length 8.1 mm (range 7.8–9.0

←

Fig. 6. Scanning electron micrographs of morphological features of kalotermitid termites. A, B, C, *Neotermes castaneus,* dorsal, dorso-lateral, lateral, respectively. D, E, F, *Neotermes jouteli.* G, H, I, *Neotermes luykxi.* J, K, L, *Incisitermes snyderi.* M, N, O, *Incisitermes schwarzi.*

mm); mean head length 1.44 mm, mean head width 1.66; eye diameter 0.4–0.5 mm ..... *Neotermes jouteli*

– Mean total body length usually less than 7.5 mm (range 6.50–7.92 mm); mean head length 1.31 mm, mean head width 1.46 mm; eye diameter less than 0.4 mm .... *Neotermes luykxi*

SOLDIERS

1. Head phragmotic, with front of face rising sharply at an angle of 50–90° to longitudinal axis; mandibles small relative to size of head capsule (Figs. 2L, 5A–F) 2
– Head not phragmotic, with front of face sloping gradually at an angle less than 45° to longitudinal axis; mandibles well developed .. 4
2. One anterior tibial spur on foretibia enlarged, well developed (Fig. 4A) ..... *Calcaritermes nearcticus*
– Tibial spurs on foretibia subequal in length [*Cryptotermes*] 3
3. Dorsum of head capsule weakly concave; surface of forehead smooth or finely crenulated (Fig. 5B, D, F) ..... *Cryptotermes cavifrons*
– Dorsum of head capsule distinctly concave; surface of forehead deeply convoluted (Fig. 5A, C, E) ..... *Cryptotermes brevis*
4. Anterior margin of pronotum neither deeply concave nor incised 5
– Anterior margin of pronotum deeply concave or incised (Fig. 1H–L) [*Incisitermes*] 10
5. Third antennal article only slightly longer than fourth; hindfemur moderately inflated, with L/W ratio greater than 3.0; head length greater than 3.4 mm; head depth greater than 1.7 mm ..... *Neotermes castaneus*
– Third antennal article subequal to or greater than articles 4 plus 5; hindfemur strongly inflated, with L/W ratio less than 2.6; head length less than 3.4 mm; head depth less than 1.5 mm 6
6. Eyes unpigmented .. *Kalotermes approximatus*
– Eyes pigmented, purplish, gray, or sooty black 7
7. Postmentum length greater than 2.00 mm 8
– Postmentum length less than 2.00 mm 9
8. Mean ratio of length of postmentum to its minimum width 7.09; head width 1.9–2.1 mm; width of pronotum usually less than 2.3 mm ..... *Neotermes luykxi* [long-headed]
– Mean ratio of length of postmentum to its minimum width 4.62; head width 2.0–2.5 mm; width of pronotum usually greater than 2.3 mm ..... *Neotermes jouteli* [long-headed]
9. Head length ca. 2.3 mm (range: 2.0–2.9 mm); head width ca. 1.9 mm (range: 1.7–2.3 mm); head depth ca. 1.3 mm (range: 1.2–1.7 mm); ratio of postmentum length to minimum width usually greater than 4.7 ..... *Neotermes jouteli* [short-headed]
– Head length less than 2.1 mm (range: 1.8–2.1 mm); head width less than 1.8 mm (range: 1.6–1.8 mm); head depth 1.2 mm (range: 1.0–1.2 mm); ratio of postmentum length to minimum width usually less than 4.5 ..... *Neotermes luykxi* [short-headed]
10. Body length less than 6.5 mm; restricted to Florida keys ..... *Incisitermes milleri*
– Body length greater than 6.5 mm; range not limited to southern tip of Florida 11
11. Head length greater than 3.0 mm; postmentum length greater than 2.4 mm ..... *Incisitermes schwarzi* [long-headed]
– Head length less than 2.6 mm; postmentum length less than 1.9 mm 12
12. Head length greater than 2.3 mm, and head width less than 1.6 mm ..... *Incisitermes snyderi* [long-headed]
– Head length less than 2.3 mm, and head width either less than 1.5 mm or greater than 1.6 mm 13
13. Head width greater than 1.6 mm; third antennal article usually longer than 4 and 5 combined; head nearly as broad as long; head L/W less than 1.40 (Fig. 1J); antenna usually with 16 articles . *Incisitermes schwarzi* [short-headed]
– Head width less than 1.5 mm; third antennal article no longer than 4 and 5 combined; head longer than broad; head L/W greater than 1.40 (Fig. 1H); antenna usually with fewer than 16 articles .. *Incisitermes snyderi* [short-headed]

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